Studies of High-Mass Ditop Resonances at a High-Lumi LHC and ATLAS

Chris Pollard, Ashutosh Kotwal

Duke University

Introduction

- Goal:
  - *Understand sensitivity to non-SM physics with simple, parameterized object reconstruction*
  - *At 14 TeV with 300/fb, 1000/fb, and 3000/fb*
- All analysis was performed on truth-level objects which were smeared according to detector resolutions.
- Trigger and reconstruction efficiencies are also taken into account.
- Pythia8 was used to generate all MC samples in these studies.

Introduction

- Considered several scenarios for possible sensitivity to non-SM physics
- Vector boson scattering
  - *WW, ZZ final states*
- High-mass exotic resonances
  - *Dilepton resonances*
  - *ttbar resonances (l+jets and dilepton final states)*
- Will focus on ttbar resonances here (see ATL-PHYS-PUB-2013-003)

High Mass ttbar Resonances

- In several BSM theories the top quark has stronger couplings to exotic particles due to its high mass.
- ttbar resonance searches also serve as a proxy for a variety of heavy decays with leptons, b-quarks, and MET.
- Signal Templates:
  - *Randall-Sundrum Kaluza-Klein Gluon*
  - *Top Color Leptophobic Z'*
- Studies modeled after previous ATLAS ttbar resonance analyses on 2011 data
- Limits shown in this talk are stats-only.

High Mass ttbar Resonances

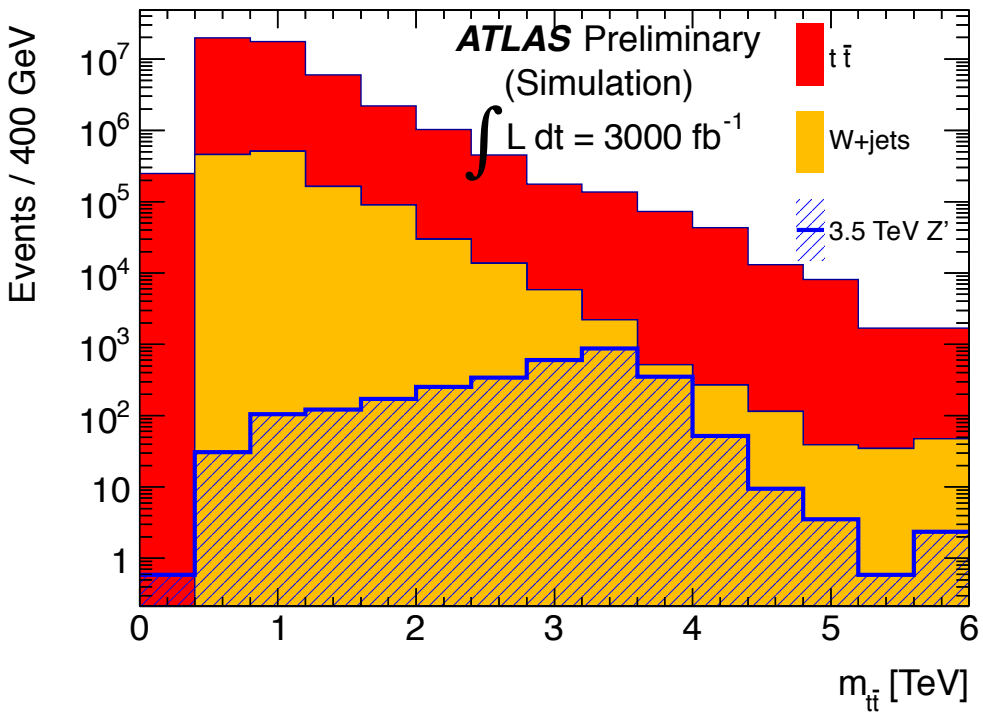
- Both lepton+jets and dilepton final states have been studied.
- Lepton+jets channel
  - *Generally more sensitive (higher branching fraction, fully-reconstructible ttbar mass)*
  - *More susceptible to pileup effects*
  - *Considered ttbar, W+jets backgrounds*
- Dilepton channel
  - *Less sensitive (lower branching fraction, two neutrinos)*
  - *Not affected as much by pileup*
  - *Considered ttbar, Z+jets, diboson backgrounds*

ttbar (Lepton+Jets) Event Selection

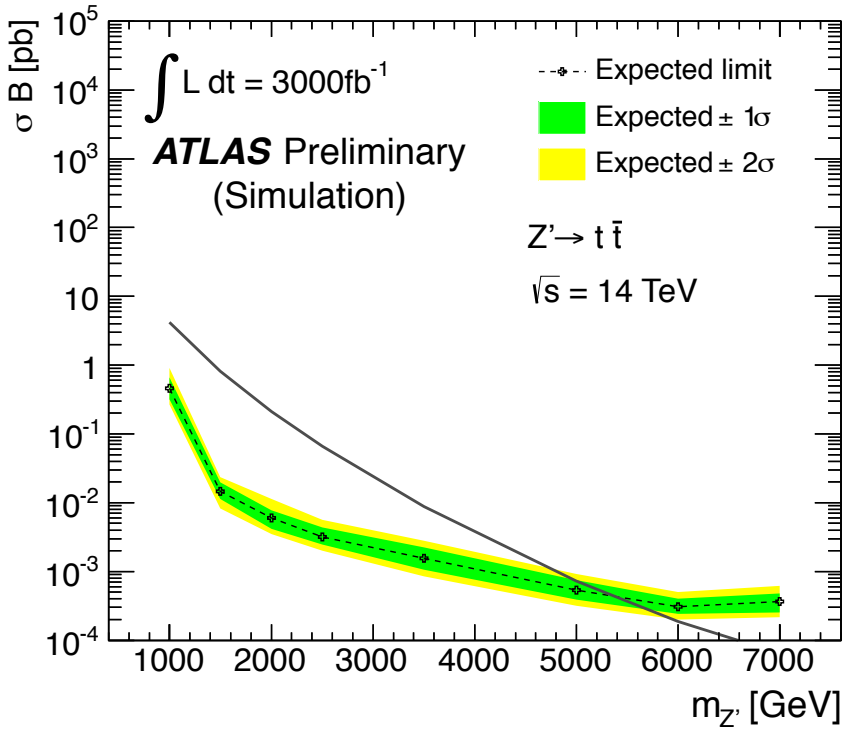
- Require:
  - *Exactly one triggered lepton with pt > 25 GeV*
  - *One anti-kt (R = 1.0) jet with pt > 250 GeV which does not overlap with selected lepton (top-jet)*
  - *One anti-kt (R = 0.4) jet with pt > 25 GeV* ***which does not overlap with selected akt10 jet*** *(leptonic b-jet)*
  - *At least 50 GeV of MET*
- W-mass constraint is used to determine neutrino pz
- Use invariant mass of lepton+neutrino+b-jet+top-jet system to set limits

l+jets Mass Spectrum and Limits

Reconstructed ttbar mass spectrum



Expected KKgluon mass limit

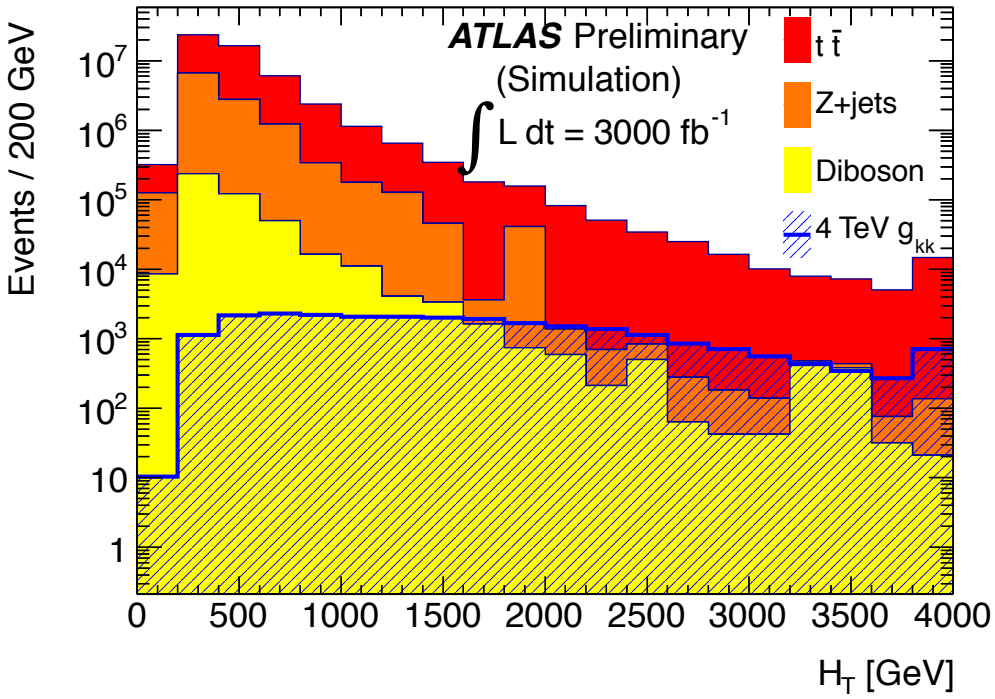


ttbar (Dilepton) Event Selection

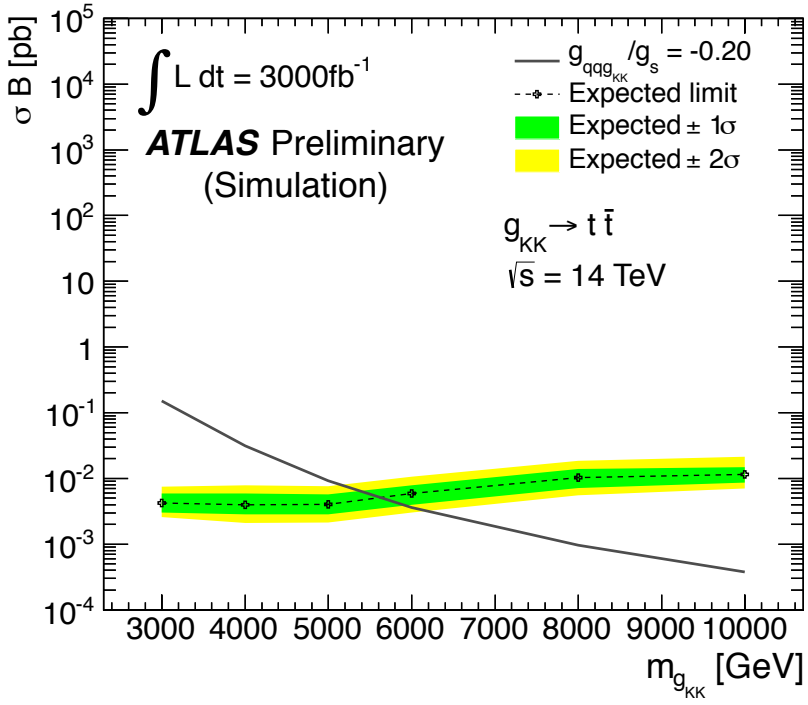
- Require:
  - *Exactly two leptons with pt > 25 GeV*
    - *At least one must fire the trigger*
  - *Two anti-kt (R = 0.4) jets with pt > 25 GeV (b-jets)*
  - *At least 50 GeV of MET*
- HT (scalar sum pt of selected leptons and b-jets plus MET) used to set limits

Dilepton H_T Spectrum and Limits

Reconstructed H_T spectrum



Expected KKgluon stat-only mass limit



ttbar Resonances Summary

Expected stat-only limits for searches at 14 TeV
in the ttbar → l+jets (dilepton) channels.
All Limits in TeV.

model	$300\,\mathrm{fb}^{-1}$	$1000\,\mathrm{fb}^{-1}$	$3000\,\mathrm{fb}^{-1}$
g_{KK}	4.3 (4.0)	5.6 (4.9)	6.7 (5.6)
$Z'_{\mathrm{Topcolour}}$	3.3 (1.8)	4.5 (2.6)	5.5 (3.2)

Future Work

- Have working analyses for the standard ttbar resonance signal templates at 14 TeV
- Studies have also been performed at 33 TeV, although they are not currently public.
- Would like to reproduce these studies outside of ATLAS software framework and compare to current results
- Cuts on substructure variables (e.g. the first subjet splitting scale) for the hadronic top would be welcome, but require some study under high pile-up conditions and in fast simulation